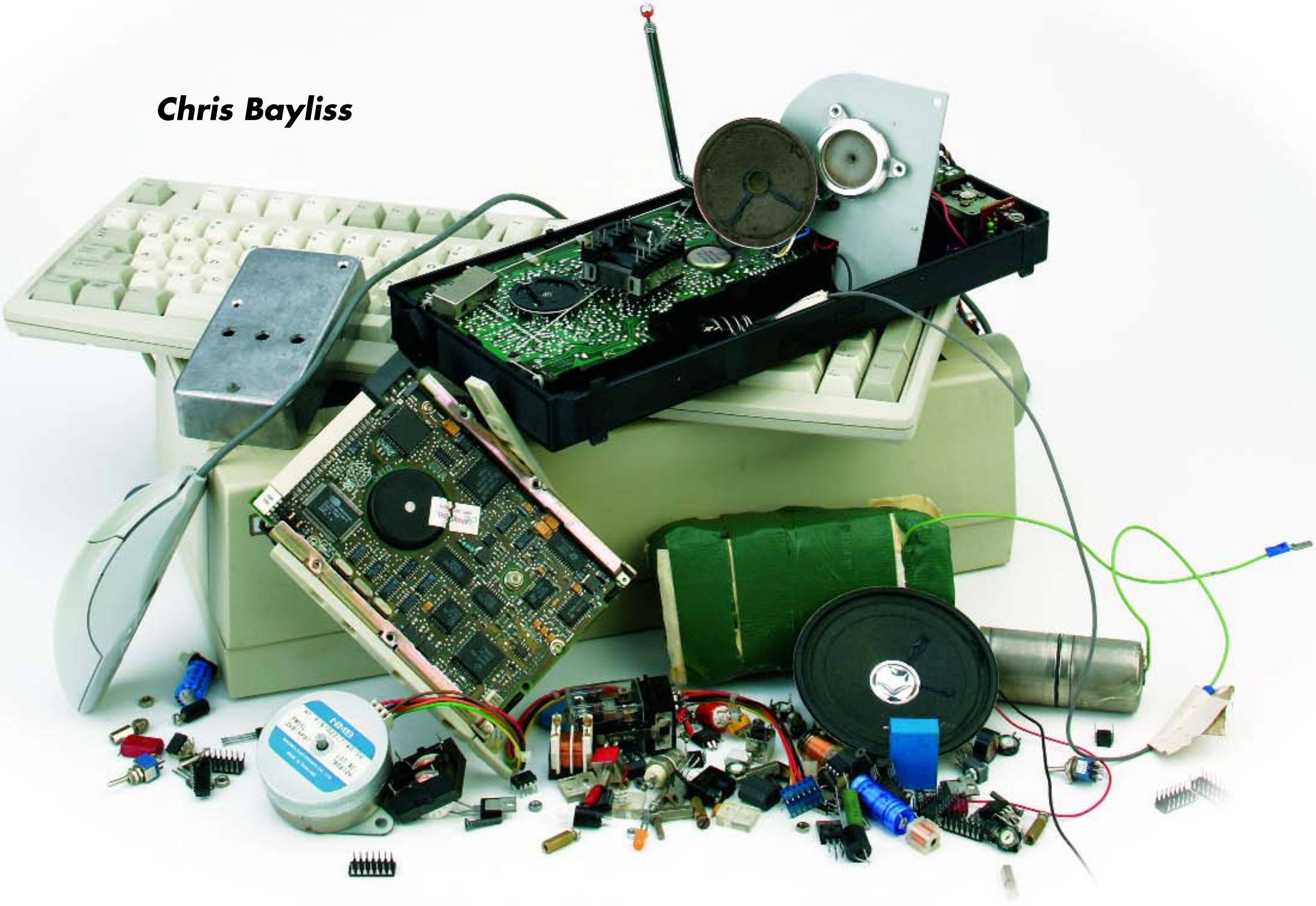
BRING OUT YOU

Chris Bayliss



In 2006 European legislation on electrical and electronic waste comes into full force. Across North America, states are passing laws to deal with electronics waste. These measures reflect a hidden but growing problem.

As any electronics enthusiast who has recently tried to repair a consumer product will know, it is more likely to be cheaper to dispose of and replace an item than to repair it. Worse still, many items on the market are likely to be in good working order at the end of their life. The keen electronics consumer faces a dilemma; a desire to own the latest technology leaves perfectly good products obsolete. At the root of this problem manufacturers are beginning to supersede their own technologies and products at an unsustainable rate. The EU estimates that 4% of household waste consists of electrical and electronics products and this figure is increasing at a worrying rate of 16-28% every five years.

A glance at the statistics and listening to green organizations would suggest a depressing future. There exists however, a movement to exploit the electronics waste problem where a positive attitude and creativity results in novel solutions.

It's all around us

A potential mountain of electronic waste surrounds us all in our homes and offices. The gap between recognizing the electronics waste problem and acting upon it has left

R DEAD

Solutions to electronic waste

us with products not designed to be repaired, or disposed of efficiently or safely.

Substances & methods

Common substances found in electrical and electronic waste include cadmium, PCB's, mercury, lead and bromine. The sheer volume and toxicity of these materials means landfill is no longer an option. After taking away the small percentage of goods sold on as 'second hand' a large quantity of obsolete and unwanted goods remain. If these are to avoid the landfill then a method of recycling is required.

Recycling an electronics product involves reducing it to component parts and converting these back into usable parts or raw materials. This can be performed by one of two methods, manual disassembly or destructive disassembly. Put simply, destructive disassembly involves the product passing through an industrial grinder. The granules produced are smelted and the raw materials separated for re-use. Considering the toxicity of some of the materials involved destructive disassembly is a rather crude method. A large quantity of destructive disassembly is performed in the Far East where labour costs are low and environmental laws relaxed. Ironically, many of these countries sell the salvaged raw materials back to the countries that exported them. A greener and more economically viable solution may be provided by manual disassembly.

If it ain't broke...

Electronics from waste products has undergone a 'burn in' period and as such, could be considered to be of a proven quality and equal to or more reliable than components fresh off the production line. The lifespan of many components now realistically exceeds that of the parent product. In theory 'harvested' components can be re-used in new products. Research has suggested that whilst theoretically possible, a psychological barrier exists at the manufacturer and consumer level at the thought of utilizing harvested components in new products.

Electronic Data Logging (EDL)

Researchers at the power tool manufacturer Bosch have made a suggestion that may help to overcome the above (quite natural) fear, the Electronic Data Logging (EDL) device.

EDL records general information ranging from life hours of the product to more specific component operating history. In theory, this information could be retrieved by the recycling agency via a 'green port' on the device with reusable parts identified, harvested and incorporated directly into new products. Successful implementation of EDL in the future may promote more recycling of parts. If harvesting offers an opportunity for a greener electronics future then how would this be performed?

Figure 1. Student at CIDA University of Johannesburg. PCs donated by Computer Aid International.

Current harvesting operations are either performed manually or using robotics. Manual disassembly involves the application of heat to remove components from boards and is a labour-intensive operation. It has enabled charities and other non-profit organizations to recycle old electronics for good causes. Computer Aid for example refurbishes PCs from corporate donors and distributes them to worthy causes in the developing world (**Figure 1**).

Many charities have also been successful in raising funds from the sale of re-conditioned or recycled mobile phones to Eastern Europe. Manual harvesting has one major drawback. The cost of skilled labour required to perform the task has proven a barrier to widespread commercial parts harvesting. This makes robotic harvesting a more attractive option. Whilst efficient for large batches of the same product, robots have to be programmed to disassemble each new product they encounter. This can make the disassembly of small batches or single electronics products impractical. The search for a commercially viable method of disassembling batches of small and

TPI Toxic Potential Indicator
ProTox Process Toxicity
Energy
RPI Material Recycling Potential Indicator
RPI Product
IZM-EE Toolbox

Figure 2. IZM/EE Toolbox promotional image. (Fraunhofer Institute)

mixed electronics waste could be considered the holy grail of the emerging electronics waste industry.

Figure 3. Blu-Ray player; 25-GB cartridge; front and rear view of disc. (Sony)

An alternative: ADSM

Like all good problems a surprisingly simple solution emerged, a team from Brunel University in the UK developed the self-disassembling product. The method known as 'Active Disassembly Using Smart Materials' (ADSM) involves the incorporation of actuators and components made from smart metals and plastics. At a pre-defined value above the ambient and operating temperature, these materials change shape. Now imagine these smart materials integrated into an electronics product. Disassembly of the product is achieved by the application of heat, no costly labour or robotics requiring programming. Smart material screws shrink and simply fall out of the product, a carefully placed smart material actuator such as a spring expands splitting open the housing. Internal components break loose from the main assembly ready for easy removal. The self-disassembling product offers an exciting future for recycling. Assuming the majority of manufacturers chose to use smart materials, recycling of mixed batches of electronics waste becomes possible. Self-disassembly offers a cheap solution, neatly sidestepping costly robotics and harmful destructive disassembly.

Designing for minimum waste

The Fraunhofer Institute has developed a software product to assist the electronics designer. The software-based IZM/EE Toolbox (**Figure 2**) enables the electronics designer to investigate a range of areas from toxicity and recyclability of a design to more abstract areas such as the energy required to produce the raw materials required, even the energy consumed by the product. In the future the electronics designer may integrate complex green issues at the design stage with the push of a button. Creative thinking at the design stage has the potential to both clean up the product life cycle and provide the consumer with desirable new technologies. Sony recently demonstrated this with their Blu-ray disc. (**Figure 3**). Consisting of 51% paper, the new disc provides greater data storage than existing DVD technology (**Figure 4**) and offers greener mass production opportunities. At the end of its working life the product can simply be shredded and recycled, offering both a green end of life solution and enhanced data security.

Dealing with electronics waste effectively either at the design or end of life stage could be considered an insurance policy for the electronics industry. The European Union already predicts that 10,500 new jobs could be created by electronics waste recycling. For the electronics consumer and enthusiast the future not only looks greener but we could be seeing some innovative new technologies emerge. Today's green electronics pioneers will lead the market tomorrow.

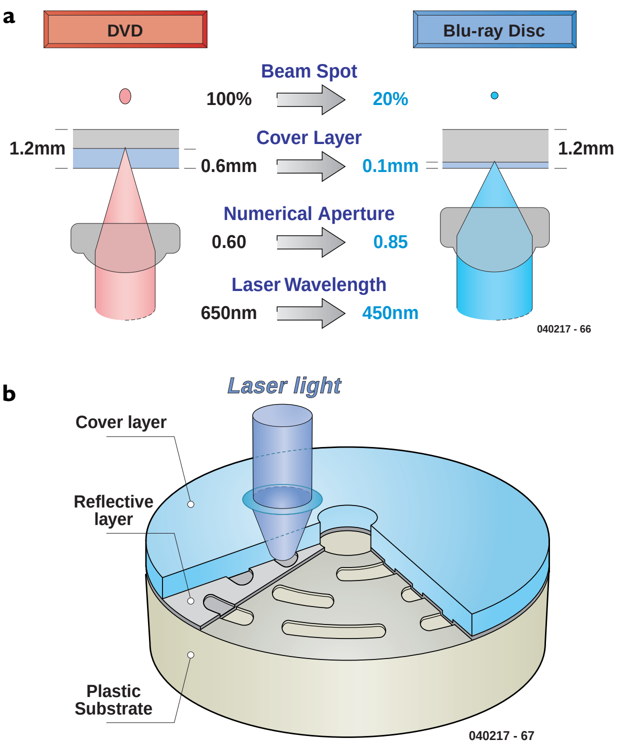


Figure 4. (a) DVD vs Blu-Ray comparison chart; (b) structure of Blu-Ray disc.

Looking East

ADSM and EDL offer pioneering solutions using available technology. All this technology still requires one essential ingredient, imagination. If we want to see electronics waste management in action then look no further than the heartland of electronics, Japan.

In 2001 Japan implemented its Electrical Home Appliances recycling law. The recycling law covers only four types of appliances; air conditioning units, televisions, fridges and washing machines. These were found to constitute a significant proportion of Japanese consumer waste.

Consumers in Japan can now return their old appliance to the vendor of their new purchase irrespective of the brand. The vendor passes the used appliance over to a recycling company. Each returned product is tagged and its recycling history recorded and stored for three years. This gives companies a unique perspective on the life cycle of their product and provides an overall picture on recycling. From the consumer end the returned product can be tracked via websites. Information regarding where the product was recycled is available. If this sounds too good to be true then you would be right. The Japanese consumer covers the cost of transporting and recycling the waste.

And West again..

Absorbing the cost of recycling the product may not prove to be a popular option with the European consumer. Avoiding added cost means returning to the drawing board and thinking about the design process.

All electronics products begin their life as a design. An integral part of this is the product life cycle. Traditionally the life cycle of an electronics product ended at the consumer. Legislation and corporate social responsibility now means manufacturers look at the impact of their product from the manufacturing process through to product disposal. To make electronics recycling work, all parts of the industry need to be involved. Realistically, not all companies have the funds or the resources available to spend time looking at issues such as recyclability and toxicity of their products. However, over recent years computer software has been developed to address this issue. Examples include two more utilities from Fraunhofer's IZM/EE Toolbox: the Toxic Potentials Indicator (TPI) (**Figures 5, 6, 7**) and the Recycling Potential Indicator (**Figure 8**). Just before printing this article, Fraunhofer Institute kindly advised that an updated and extended version of the IZM/EE Toolbox documentation is due for release by the end of this year.

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Web Pointers

[1] http://europa.eu.int/scadplus/leg/en/lvb/l21210.htm
[2] www.ban.org
[3] www.computer-aid.org
[4] www.brunel.ac.uk/research/adsm/home.html
[5] www.matsushita.co.jp/environment/en/metec/index.html
[6] www.pb.izm.fhg.de/ee/070_services/75_toolbox/010_Einleitung.html
[7] www.blu-raydisc-official.org/
[8] www.electronicsrecycling.org http://www.icer.org.uk/

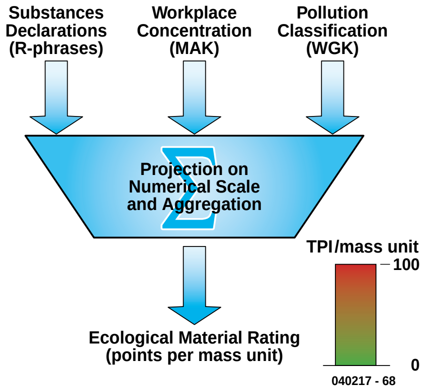
Substances Declarations (R-phrases)
Workplace Concentration (MAK)
Pollution Classification (WGK)
Projection on Numerical Scale and Aggregation
TPI/mass unit
100
0
Ecological Material Rating (points per mass unit)
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Figure 5. Toxic Potential Indicator (TPI) software enables calculation of product toxicity during product design stage. (Fraunhofer Institute)

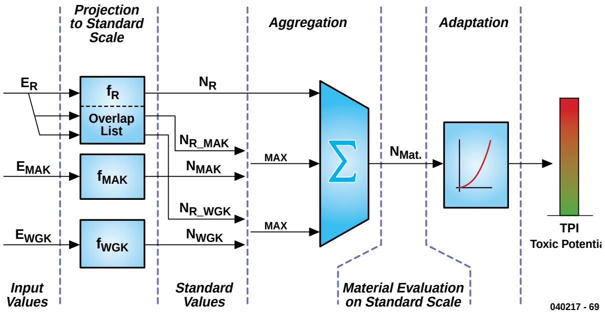
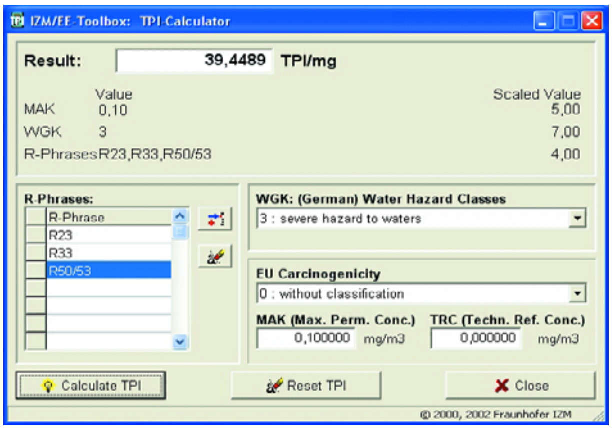


Figure 6. A more in-depth description of the TPI calculation process. (Fraunhofer Institute)



Result: 39,4489 TPI/mg

	Value	Scaled Value
MAK	0,10	5,00
WGK	3	7,00
R-Phrases	R23,R33,R50/53	4,00

R-Phrases:

R-Phrase
R23
R33
R50/53

WGK: (German) Water Hazard Classes: 3 : severe hazard to waters

EU Carcinogenicity: 0 : without classification

MAK (Max. Perm. Conc.): 0,100000 mg/m3

TRC (Techn. Ref. Conc.): 0,000000 mg/m3

Figure 7. Example of TPI in action. (Fraunhofer Institute)

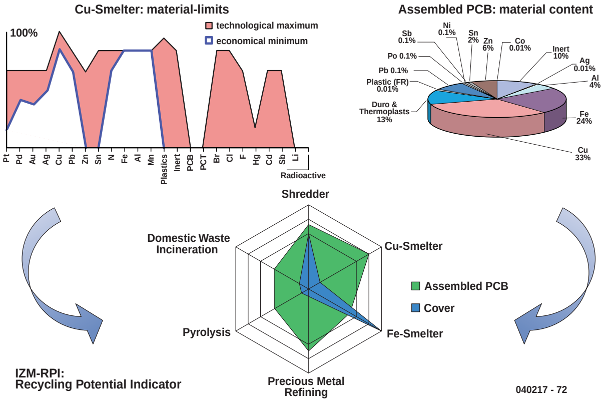


Figure 8. The Recycling Potential Indicator (RPI) utility from the IZM/EE Toolbox allows calculation of proportion of recyclable material in product at an early stage. (Fraunhofer Institute)